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M E M O R A N D U M

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SUBJECT: EXPOSURES TO METHYL BROMIDE BASED ON THE DRAFT REPORT ON THE 2001 MONITORING IN OXNARD/CAMARILLO AND SANTA MARIA BY THE ALLIANCE OF THE METHYL BROMIDE INDUSTRY

Methods

Exposures are expressed here as concentrations of methyl bromide in air for several averaging periods.

The Alliance of the Methyl Bromide Industry (AMBI) draft report gives median concentrations calculated nonparametrically (Oxnard) or means estimated using lognormal methods (Santa Maria), depending on the results of statistical tests of normality and lognormality. Insufficient detail is provided to know how the calculations were done, and the reported summary statistics could not be reproduced.

Following the practice of the Worker Health and Safety (WHS) Branch, this memorandum reports arithmetic mean concentrations and tolerance limits estimated using lognormal methods. Lognormality is assumed for environmental contaminants in most cases. DPR's experience with many large environmental datasets has shown that they are usually well described by the lognormal distribution. In the present case, the lognormal fit rejected for the Oxnard data in the AMBI draft report is reasonably good. In addition, WHS prefers to avoid the inconsistency introduced by using different exposure statistics based on sample characteristics. WHS uses the arithmetic mean concentration because the concentration of interest for exposure assessment is the overall concentration in all of the air that a person could breathe during the averaging period. The arithmetic mean concentration is the best estimate of the average mass of residue per unit of environmental medium; it is equivalent to compositing all of the samples and measuring the concentration of the mixture (Parkhurst, 1998). This is true regardless of the shape of the underlying distribution.

No samples below the detection limit of 0.003 ppbv were reported. There were four cases where a site had only one sample for a week; this value was used as both the mean and the maximum 24-hour concentration for the week at that site. The data were not adjusted for background levels because the concentrations detected were low (average 0.01 ppbv in 12 trip blanks), nor for recovery, since it was barely outside the $\pm$ 20% range that DPR considers good (average 121% in 41 laboratory spikes).

24-hr exposure

For each monitoring site separately, the maximum observed and the 95% tolerance limit for 24-hr concentrations are given. The 95% tolerance limit is the concentration that, with given probability, will be exceeded in 5% of future samples (Hahn and Meeker, 1991). It is calculated using lognormal distribution methods:

      95% tolerance limit = exp{arithmetic mean of log concentrations + $g_{(.90;95;\,n)}$*(sd of logs)}.

The multiplier g for 90% probability is tabled in Hahn and Meeker (1991).

1-week exposure

For each monitoring site separately, the maximum and the 95% tolerance limit for weekly mean concentrations are given. Each weekly mean is calculated as the arithmetic mean of the 24-hr samples taken at a site during the week (i.e., nonmonitoring days are ignored). The 95% tolerance limit for weekly mean concentrations is calculated using normal distribution methods:

$$95\% \text{ tolerance limit} = \text{arithmetic mean of week means} + g_{(.90;.95;\,n)}*(\text{sd of week means}).$$

Normal methods are used in this case because sample means from any distribution tend to be normally distributed.

8-week exposure

For each monitoring site separately, average exposure over the 8-week monitoring period is calculated as the arithmetic mean of the weekly means (calculated as above for 1-week exposure).

Results

Twenty-four-hour, 1-week and 8-week concentrations are presented in Table 1.   Daily concentrations and intermediate calculations are shown in Tables 2 and 3.

Table1. Methyl bromide concentrations (ppbv) in Oxnard/Camarillo and Santa Maria, 2001, based on monitoring by the Alliance of the Methyl Bromide Industry.

Site [a]	n days	Daily Maximum 24-hr	Daily 95% tolerance limit	1-week Maximum weekly [b] mean	1-week 95% tolerance limit	8-week Mean of weekly means
Oxnard/Camarillo (15 Aug – 10 Oct, 2001) ppbv						
PVW	30	3.17	2.68	2.01	2.59	0.56
UWC	19	4.35	8.77	2.08	3.48	0.82
SHA	29	3.38	2.41	2.47	2.73	0.51
ABD	21	0.44 [c]	0.44	0.44 [c]	0.58	0.18
Santa Maria (23 Aug – 9 Oct, 2001) ppbv						
BLO	31	4.55	4.85	1.89	2.25	0.73
AGCCRS	28	1.16	1.28	0.85	1.00	0.28
EDW	30	11.15	10.57	6.49	7.10	1.32
PNT	24	2.69	4.62	1.75	2.26	0.93

a Monitoring sites described in AMBI (2002).
b Each weekly mean is the arithmetic mean of the 24-hr samples (*n* ranged 1 - 5) in a calendar week.
c Measured in a week with only one 24-hr sample.

Exposure appraisal

The average concentrations presented here are based on limited monitoring data and must be considered as having some degree of uncertainty. The representativeness of the four monitoring sites in each county is unknown. Each site was monitored only 1-5 days per week for a relatively short (8-week) period. Different days were monitored each week. In some weeks (five in Oxnard, three in Santa Maria), weekend days were monitored. It is unknown whether weekdays and weekends differ systematically in numbers of methyl bromide fumigations. Two Oxnard sites had no data for two monitoring weeks. In four cases, only one 24-hour sample was available at a site for the week.

The timing and location of nearby methyl bromide applications, which influence air concentrations, are not yet known for the monitoring period. Monitoring at the Oxnard UWC site was intentionally skipped, however, during two weeks when applications were known to be taking place nearby.

References

AMBI. 2002. Draft preliminary report: Methyl bromide ambient air monitoring in Oxnard/Camarillo and Santa Maria, August-October, 2001. Draft dated Feb. 15. Sacramento, CA: Alliance of the Methyl Bromide Industry.

Hahn, G.J., and Meeker, W.Q. 1991. *Statistical Intervals: A Guide for Practitioners*. New York, John Wiley & Sons, Inc.

Parkhurst, D.F. 1998. Arithmetic versus geometric means for environmental concentration data. *Environmental Science and Technology News*. Feb. 1.

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Table 2. Daily concentrations and intermediate calculations for Oxnard/Camarillo.

Oxnard/Camarillo	All units: ppbv						ln(ppbv)					
DATE	Week	PVW	UWC	SHA	ABD		DATE	Week	PVW	UWC	SHA	ABD
15-Aug-01	1	1.82	2.58	0.69		Wed	15-Aug-01	1	0.60	0.95	-0.37	
16-Aug-01	1	1.05	1.85	0.17		Thur	16-Aug-01	1	0.05	0.61	-1.77	
17-Aug-01	1	3.17	1.80	0.18		Fri	17-Aug-01	1	1.15	0.59	-1.73	
18-Aug-01	1						18-Aug-01	1				
19-Aug-01	1						19-Aug-01	1				
	1 Average	2.01	2.08	0.35								
20-Aug-01	2						20-Aug-01	2				
21-Aug-01	2	0.50	1.53			Tue	21-Aug-01	2	-0.70	0.42		
22-Aug-01	2	1.91	0.45			Wed	22-Aug-01	2	0.65	-0.79		
23-Aug-01	2	2.49	4.35	2.94		Thur	23-Aug-01	2	0.91	1.47	1.08	
24-Aug-01	2		2.01	3.38		Fri	24-Aug-01	2		0.70	1.22	
25-Aug-01	2	0.81	0.25	1.09		Sat	25-Aug-01	2	-0.21	-1.40	0.09	
26-Aug-01	2						26-Aug-01	2				
	2 Average	1.43	1.72	2.47								
27-Aug-01	3						27-Aug-01	3				
28-Aug-01	3	0.12	0.21	1.09		Tue	28-Aug-01	3	-2.11	-1.54	0.08	
29-Aug-01	3	0.15	0.10	0.07		Wed	29-Aug-01	3	-1.90	-2.29	-2.70	
30-Aug-01	3	0.28	0.35	0.56	0.44	Thur	30-Aug-01	3	-1.29	-1.05	-0.58	-0.83
31-Aug-01	3	0.15	0.18			Fri	31-Aug-01	3	-1.87	-1.74		
1-Sep-01	3						1-Sep-01	3				
2-Sep-01	3						2-Sep-01	3				
	3 Average	0.18	0.21	0.57	0.436							
3-Sep-01	4						3-Sep-01	4				
4-Sep-01	4						4-Sep-01	4				
5-Sep-01	4						5-Sep-01	4				
6-Sep-01	4	0.20		0.04	0.05	Thur	6-Sep-01	4	-1.61		-3.27	-2.96
7-Sep-01	4	0.10		0.03	0.13	Fri	7-Sep-01	4	-2.30		-3.41	-2.03
8-Sep-01	4	0.07		0.05	0.13	Sat	8-Sep-01	4	-2.67		-3.02	-2.08
9-Sep-01	4	0.16		0.23	0.39	Sun	9-Sep-01	4	-1.85		-1.47	-0.93
	4 Average	0.13		0.09	0.18							
10-Sep-01	5						10-Sep-01	5				
11-Sep-01	5						11-Sep-01	5				
12-Sep-01	5						12-Sep-01	5				
13-Sep-01	5	0.17		0.38	0.07	Thur	13-Sep-01	5	-1.80		-0.98	-2.67
14-Sep-01	5	0.15		0.07	0.10	Fri	14-Sep-01	5	-1.93		-2.69	-2.27
15-Sep-01	5			0.13	0.15	Sat	15-Sep-01	5			-2.04	-1.92
16-Sep-01	5	0.29		0.11	0.11	Sun	16-Sep-01	5	-1.25		-2.17	-2.17
	5 Average	0.20		0.17	0.11							

Table 2. Continued.

Date	n	v1	v2	v3	v4	Day	Date	n	w1	w2	w3	w4
17-Sep-01	6	0.35		0.13	0.14	Mon	17-Sep-01	6	-1.05		-2.02	-2.00
18-Sep-01	6						18-Sep-01	6				
19-Sep-01	6	0.18	0.18	0.10	0.10	Wed	19-Sep-01	6	-1.71	-1.71	-2.32	-2.28
20-Sep-01	6	0.59	0.30	0.36	0.11	Thur	20-Sep-01	6	-0.53	-1.19	-1.03	-2.21
21-Sep-01	6						21-Sep-01	6				
22-Sep-01	6						22-Sep-01	6				
23-Sep-01	6						23-Sep-01	6				
6 Average		0.37	0.24	0.20	0.12							
24-Sep-01	7						24-Sep-01	7				
25-Sep-01	7						25-Sep-01	7				
26-Sep-01	7	0.17	0.60	0.45	0.25	Wed	26-Sep-01	7	-1.79	-0.52	-0.81	-1.37
27-Sep-01	7	0.08		0.09	0.12	Thur	27-Sep-01	7	-2.48		-2.38	-2.10
28-Sep-01	7	0.08		0.10	0.15	Fri	28-Sep-01	7	-2.48		-2.32	-1.88
29-Sep-01	7	0.11		0.19	0.19	Sat	29-Sep-01	7	-2.20		-1.67	-1.64
30-Sep-01	7	0.15		0.07	0.06	Sun	30-Sep-01	7	-1.93		-2.65	-2.87
7 Average		0.12	0.60	0.18	0.16							
1-Oct-01	8						1-Oct-01	8				
2-Oct-01	8						2-Oct-01	8				
3-Oct-01	8						3-Oct-01	8				
4-Oct-01	8						4-Oct-01	8				
5-Oct-01	8						5-Oct-01	8				
6-Oct-01	8						6-Oct-01	8				
7-Oct-01	9	0.06	0.07	0.10	0.04	*Sun*	7-Oct-01	9	-2.80	-2.73	-2.34	-3.17
8-Oct-01	9	0.05	0.05	0.05	0.06	Mon	8-Oct-01	9	-3.04	-2.91	-3.02	-2.75
9-Oct-01	9	0.09	0.07	0.07	0.10	Tue	9-Oct-01	9	-2.44	-2.73	-2.73	-2.27
10-Oct-01	9	0.10	0.07	0.11	0.11	Wed	10-Oct-01	9	-2.29	-2.70	-2.24	-2.20
9 Average		0.07	0.06	0.08	0.08							
Mean of week means		**0.56**	**0.82**	**0.51**	**0.18**		Overall mean of days		-1.43	-0.98	-1.70	-2.12
SD of week means		0.74	0.86	0.81	0.13		Overall SD of days		1.16	1.41	1.23	0.60
Max of week means		**2.01**	**2.08**	**2.47**	**0.44**		n days		30	19	29	21
n weeks		8	6	8	6							
95th %ile of week means		**1.96**	**2.55**	**2.04**	**0.44**							
90% tol limit on 95th %ile		**2.59**	**3.48**	**2.73**	**0.58**							
Max of days		**3.17**	**4.35**	**3.38**	**0.44**		**95th %ile of days**		**1.72**	**4.37**	**1.49**	**0.34**
							90% tol limit on 95th		**2.68**	**8.77**	**2.41**	**0.44**

Table 3. Daily concentrations and intermediate calculations for Santa Maria.

Santa Maria	ppbv						ln(ppbv)					
DATE	Week	BLO	AGC	EDW	PNT		DATE	Week	BLO	AGC	EDW	PNT
23-Aug-01	2	0.04	0.03	0.02		Thur	23-Aug-01	2	-3.12	-3.47	-4.07	
24-Aug-01	2	0.03	0.13	1.02		Fri	24-Aug-01	2	-3.44	-2.01	0.02	
25-Aug-01	2	0.68	0.11	0.69		Sat	25-Aug-01	2	-0.39	-2.23	-0.38	
26-Aug-01	2	3.46	0.13	1.33	0.34	Sun	26-Aug-01	2	1.24	-2.02	0.29	-1.08
	2 Average	1.05	0.10	0.76	0.34							
27-Aug-01	3	2.09	0.14	0.98	0.68	Mon	27-Aug-01	3	0.74	-2.00	-0.02	-0.38
28-Aug-01	3	0.19	0.06	0.44	0.10	Tue	28-Aug-01	3	-1.67	-2.88	-0.81	-2.28
29-Aug-01	3	0.34	0.02	0.32	1.29	Wed	29-Aug-01	3	-1.08	-3.73	-1.14	0.25
30-Aug-01	3	0.30	0.06	0.58	1.68	Thur	30-Aug-01	3	-1.19	-2.78	-0.54	0.52
31-Aug-01	3						31-Aug-01	3				
1-Sep-01	3						1-Sep-01	3				
2-Sep-01	3						2-Sep-01	3				
	3 Average	0.73	0.07	0.58	0.94							
3-Sep-01	4						3-Sep-01	4				
4-Sep-01	4	0.07	0.05	0.30	0.22	Tue	4-Sep-01	4	-2.70	-3.10	-1.22	-1.51
5-Sep-01	4	0.17	0.05	0.09	0.43	Wed	5-Sep-01	4	-1.80	-3.08	-2.42	-0.85
6-Sep-01	4	0.21	0.13	0.59	0.51	Thur	6-Sep-01	4	-1.55	-2.01	-0.52	-0.67
7-Sep-01	4	0.11		0.20		Fri	7-Sep-01	4	-2.19		-1.59	
8-Sep-01	4						8-Sep-01	4				
9-Sep-01	4						9-Sep-01	4				
	4 Average	0.14	0.07517	0.30	0.39							
10-Sep-01	5						10-Sep-01	5				
11-Sep-01	5	1.47	0.15	1.30	1.81	Tue	11-Sep-01	5	0.38	-1.90	0.26	0.59
12-Sep-01	5		0.21	0.68	0.78	Wed	12-Sep-01	5		-1.57	-0.39	-0.25
13-Sep-01	5	0.40	0.21	0.64	0.59	Thur	13-Sep-01	5	-0.91	-1.57	-0.44	-0.54
14-Sep-01	5	0.51	0.20	1.01	1.07	Fri	14-Sep-01	5	-0.67	-1.63	0.01	0.07
15-Sep-01	5						15-Sep-01	5				
16-Sep-01	5	0.78					16-Sep-01	5	-0.25			
	5 Average	0.79	0.19	0.91	1.06							
17-Sep-01	6	0.31	0.14	0.54	0.57	Mon	17-Sep-01	6	-1.18	-1.94	-0.62	-0.57
18-Sep-01	6	0.33	0.37	0.83		Tue	18-Sep-01	6	-1.12	-1.01	-0.19	
19-Sep-01	6	0.42	0.30	0.49		Wed	19-Sep-01	6	-0.87	-1.22	-0.72	
20-Sep-01	6						20-Sep-01	6				
21-Sep-01	6						21-Sep-01	6				
22-Sep-01	6						22-Sep-01	6				
23-Sep-01	6						23-Sep-01	6				
	6 Average	0.35	0.27	0.62	0.57							

Table 3. Continued.

Date	n					Day	Date	n				
24-Sep-01	7	2.22	0.20	4.09	1.24	Mon	24-Sep-01	7	0.80	-1.62	1.41	0.22
25-Sep-01	7	1.12		7.08		Tue	25-Sep-01	7	0.11		1.96	
26-Sep-01	7	0.34	0.42	11.15	0.55	Wed	26-Sep-01	7	-1.09	-0.87	2.41	-0.60
27-Sep-01	7	1.20	0.72	4.05	0.83	Thur	27-Sep-01	7	0.18	-0.33	1.40	-0.19
28-Sep-01	7						28-Sep-01	7				
29-Sep-01	7						29-Sep-01	7				
30-Sep-01	7	4.55		6.08	2.69	Sun	30-Sep-01	7	1.52		1.81	0.99
	7 Average	1.89	0.45	6.49	1.33							
1-Oct-01	8	0.24	0.90	0.38	1.98	Mon	1-Oct-01	8	-1.44	-0.11	-0.98	0.68
2-Oct-01	8	0.52	1.16	0.68	1.85	Tue	2-Oct-01	8	-0.65	0.15	-0.39	0.62
3-Oct-01	8	0.24	0.48	0.22	1.43	Wed	3-Oct-01	8	-1.45	-0.74	-1.52	0.36
4-Oct-01	8						4-Oct-01	8				
5-Oct-01	8						5-Oct-01	8				
	8 Average	0.33	0.85	0.42	1.75							
6-Oct-01	9	0.58	0.08	0.36	0.82	Sat	6-Oct-01	9	-0.54	-2.58	-1.03	-0.20
7-Oct-01	9	0.52	0.21		0.93	Sun	7-Oct-01	9	-0.66	-1.56		-0.07
8-Oct-01	9	0.21	0.17	0.26	0.21	Mon	8-Oct-01	9	-1.57	-1.79	-1.34	-1.57
9-Oct-01	9	1.04	0.39	0.82	2.26	Tue	9-Oct-01	9	0.04	-0.95	-0.20	0.82
	9 Average	0.59	0.21	0.48	1.06							
Mean of week means		0.73	0.28	1.32	0.93		Overall mean of days		-0.86	-1.80	-0.37	-0.24
SD of week means		0.55	0.26	2.10	0.48		Overall SD of days		1.17	0.98	1.31	0.82
Max of week means		1.89	0.85	6.49	1.75		n days		31	28	30	24
n weeks		8	8	8	8							
95th %ile of week means		1.77	0.77	5.29	1.85							
90% tol limit on 95th %ile		2.25	1.00	7.10	2.26		95th %ile of days		3.10	0.87	6.42	3.24
Max of days		4.55	1.16	11.15	2.69		90% tol limit on 95th		4.85	1.28	10.57	4.62